

Silage production and the chemical composition of corn and Grass-Tanzania intercropping

Produção e composição química da silagem de milho e capim-Tanzânia em consórcio

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Abstract

The objective of this study was to evaluate the production and chemical composition of silages of grass Tanzania and corn, grown single or intercropping. The experiment was conducted at UTFPR Câmpus Dois Vizinhos in the period between October 2011 and July 2012, a 600 m² area. The treatments were: TMI - single corn, TMT - corn and grass Tanzania consortium at the time of sowing, TT - Tanzania grass single, TT32 - grass Tanzania silage to 32% dry matter (content similar to that of corn). The experimental design a randomized block design with four treatments and five replications. Agronomic evaluations were performed 120 days after planting, as follows: number of linear-1 plants metro, plant height and ear insertion and number of ears.plants⁻¹. In the grass we evaluated canopy height, where it was held the botanical separation in green leaves, dried and stem. Silage started being held in 100 mm PVC pipe (mini-silos) kept sealed for 60 days. At the time of opening of the silo were determined the following parameters: DM, pH, total loss of DM (PDM), specifies mass (SM), dry matter recovery indices (IRDM), losses gas (LG), and size particle. Chemical analysis of the results of OM, MM, ADF were higher for TMI treatments, TT and TT, respectively. CP and LIG had superior results for the treatments containing grass. Corn intercropping with grass Tanzania silage provides more crude protein and lignin compared to exclusive corn silage without damaging the crop yield. Silage maiden Tanzania has higher levels of ADF and crude protein as well as increased production of dry matter than corn silage. The grass Tanzania should be harvested with 30% DM as presented better pH values, higher dry matter recovery rate, less loss of gas as well as increased production of dry matter that Tanzania harvested at the same age corn.

Key words: Analysis bromatological. Forage conservation. Intercropping. Microsilos.

Resumo

Objetivou-se avaliar a produção e composição bromatológica de silagens de capim Tanzânia e de milho, cultivados solteiros ou consorciados. O experimento foi conduzido na UTFPR Câmpus Dois Vizinhos no período entre outubro de 2011 e julho de 2012, numa área de 600 m². Os tratamentos utilizados foram: TMI - milho solteiro, TMT - milho e capim-Tanzânia consorciados no momento da semeadura, TT - capim-Tanzânia solteiro, TT32 - capim-Tanzânia ensilado a 32% de matéria seca (teor semelhante

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ao do milho). O delineamento experimental foi em blocos ao acaso, com quatro tratamentos e cinco repetições. As avaliações agrônomicas foram realizadas 120 dias após a semeadura, sendo elas: número de plantas metro linear⁻¹, altura da planta e inserção de espiga e número de espigas planta⁻¹. No capim avaliou-se altura do dossel, onde foi realizada a separação botânica em folhas verdes, secas e colmo. A ensilagem foi realizada em tubos de PVC de 100 mm (microsilos), mantidos vedados por 60 dias. No momento da abertura do silo foram determinados os seguintes parâmetros: MS, pH, perda total de MS (PMS), massa específica (ME), índice de recuperação de massa seca (IRMS), perdas de gases (PG), e tamanho de partícula. Das análises bromatológicas os resultados de MO, MM, FDA foram superiores para os tratamentos TMI, TT e TT, respectivamente. PB e LIG tiveram resultados superiores para os tratamentos contendo capim. O consórcio de milho com Capim Tanzânia proporciona silagem com maior teor de proteína bruta e lignina em comparação com a silagem exclusiva de milho, sem prejudicar a produtividade da cultura. A silagem de Tanzânia solteira apresenta maiores teores de FDA e de proteína bruta, além de maior produção de matéria seca que a silagem de milho. O capim Tanzânia deve ser colhido com 30% de MS visto que apresentou melhores valores de pH, maior índice de recuperação de MS, menor perda de gases, além de maior produção de matéria seca, do que a Tanzânia colhida com a mesma idade do milho.

Palavras-chave: Composição bromatológica. Conservação de forragem. Consorciação. Microsilos.

Introduction

One of the ways of using the grain for animal feeding is the production of silage, which is basically the partial fermentation of the plant. The main source for the silage is corn, for having between 30% and 35% dry matter (DM), more than 3% carbohydrates, low cap power and good microbial fermentation (ZEOULA et al., 2003). Corn is used in animal feeding in the form of grains or preserved (silage) in times of scarcity of pasture. In addition, influences on soil tillage, rotating crops in crop livestock integration system, eliminating pests, providing coverage for the soil in the post-harvest period, among other benefits. The constant search for alternatives for preserving food bulky to ruminants has enabled producers to diversify the productive system, allowing the same not being exclusively dependent of corn silage that despite its high production potential and qualitative features high cost for deployment, management and harvesting of corn, but still becomes a low-cost food per kilogram of dry matter by its high mass production (EMBRAPA, 2005).

Grass-Tanzania is characterized as a high productivity highly palatable grass (from 24 to 38 ton. of DM ha year⁻¹), with great participation

of leaves, which results in high nutritional value with an average dry matter digestibility (IVDMD) of 61.7%. This quality is enough to be included in the diet of animals in times of food shortages in the saved form (silage). Combined planting produces multiple benefits to producers, the environment and culture due to the different practices adopted to adapt to the ground for the recovery of degraded areas, with the improvement of the physical and chemical soil conditions due to the deployment of the pastures and exploitation of residual nutrients of crops for the production of fodder for the dry season.

The replacement of corn and sorghum silages, traditionally used in animal feed, for the grass silages, has arousing the interest as a reserve during the period of shortage of pasture. Thus, silages can also be produced with grasses as raw material; when there is a good production, the surplus is used for this purpose. This process has been more used over the years and its use leads to an increase in production by area and fewer losses, when compared to corn, for example (CORRÊA et al., 2002). However the values by carbohydrates and raw material represent their negative point, being both low and negatively altering the fermentation

process by decreasing the nutritional quality of the food, making necessary the supplementation with other sources of nutrients.

The objective was to evaluate the production and bromatological composition of grass-Tanzania and corn, grown single or intercropping.

Material and Methods

The experiment was conducted at the Núcleo de Ensino e Pesquisa de Ruminantes (NEPRU) of

the Federal University of Technology of the Dois Vizinhos Paraná campus in the period between October 2011 and July 2012. The experimental station is located in the Southwest region of Paraná, at a latitude 25° 44 " South and longitude of 53° 04" West, with an altitude of 520 m. The climate of the region is classified as Cfa (humid subtropical) without a defined dry season, with an average temperature on the hottest month of 22° C, according to Köppen (Table 1). The local soil is of dystrophical red nitro-soil type (BHERING; SANTOS, 2008).

Table 1. Average values of air temperature (maximum and minimum), relative humidity (RH) and precipitation during the period from September 2011 to February 2012. *Dois Vizinhos* (PR), 2011/2012.

Mês	Temperature (°C)			RH (%)	Precipitation (mm)
	Minimum	Maximum	Means		
October	10,6	33	21,25	67,7	234
November	12,1	33	21,63	67,6	139
Dezember	11	35,7	23,4	63,9	42,6
January	15,1	33,1	23,04	68,8	177,4

Source: Meteorological data - Dois Vizinhos (INMET, 2011).

The experimental design used was random blocks with four treatments (TMI-single corn, TMT - intercropping corn and grass-Tanzania at the time of sowing, TT -single grass-Tanzania harvested at the same time of corn, TT32 - grass-Tanzania silage at 32% of dry matter (content similar to corn) divided into 20 plots with dimensions of 5 x 6 m with an area of 30 m², of which 6 m² corresponds

to the surround of each parcel , totaling an area of 600 m², with five repetitions where all treatments were distributed. For the harvest of grass-Tanzania at 32% of dry matter samples were collected before the harvest and when it reached the expected value (32% of DM) the plots were harvested. However, due to the variability of the material harvested the actual dry matter was around 30% (Table 2).

Table 2. Bromatological composition of corn silages and Tanzania in single and intercropping crops. Dois Vizinhos (PR), 2011/2012.

Variables ¹	Treatments ²				Means	P>F
	Crops	Crops+tanz.	Tanzania	Tanzania 32%		
DM	30,3±0,98A	26,7±1,10A	22,0±0,98B	30,4±0,98A	27,59	0,0014
MM	4,5 ±0,32C	5,8±0,36B	10,7±0,32A	9,9±0,32A	7,68	0,0001
OM	95,5±0,32A	94,2±0,36B	89,7±0,32C	90,1±0,32C	92,32	0,0001
ADF	27,9±1,79C	34,9±2,07B	45,7±1,79A	38,7±1,79B	36,87	0,0002
NDF	65,98±1,85	69,29±1,85	65,57±1,85	61,90±1,85	65,68	0,0949
CP	10,4±0,67B	11,7±0,78A	12,7±0,67A	10,9±0,67A	11,34	0,0261
LIG	5,4±0,65B	8,4±0,80A	9,2±0,69A	8,1±0,69A	7,73	0,0141
EE	3,5±0,46	4,6±0,54	3,8±0,47	3,5±0,47	3,78	0,4171
ADIN	0,07±0,02	0,09±0,02	0,15±0,02	0,12±0,01	0.11	0,1439

DM ¹: dry matter; MM: mineral matter; OM: organic matter; ADF: acid detergent fiber; NDF: neutral detergent fiber; CP: crude protein; LIG: lignin; EE: ether extract; ADIN: acid detergent insoluble nitrogen.

² different Letters in the same line indicate that the treatments differ to 5 of significance by Tukey test.

The planting was held on 10/08/2011, with a no-tillage seeder into an area of crop-livestock integration, on a swathe of black oats. In the treatments with corn, it was prescribed a 90 cm spacing between rows, and 6 to 7 seed density / linear meter⁻¹ resulting in a population between 60000 to 70000 plants ha⁻¹, with a depth of planting between 3 to 5 cm. In the intercropping, the deployment of grass-Tanzania occurred between the lines of maize, thus obtaining two lines of grass per one of corn, the cultural value of grass was 75.3, with purity of 90 and 80 of viable seeds. The spacing between rows was of 30 cm, depth between 2 to 3 cm and sowing density of 12.8 kg ha⁻¹.

On the basic fertilizer were used 600 kg ha⁻¹ of NPK fertilizer formula 08-18-2 and on the fertilization of coverage were used 120 kg of N ha⁻¹, fractioned in two applications, using urea as nitrogen source (45%). The first application occurred at 48 days and the second 62 days after deployment.

The agronomic evaluation on corn culture was performed 120 days after planting, to wit: plant number linear meter⁻¹, plant height, ear insertion height and number of ear per plant⁻¹. For botany separation five plants of each treatment were removed randomly, the variables observed were:

dead and vivid leaves, ears, culm, tassel, cob and straw. In the grass canopy height was evaluated, where it was held the botanical separation, separating the green and dried leaves and culm. The samples obtained in the botanical separation were taken to an oven at 55° C for 72 hours, determining the dry matter of both species.

Silage began when the corn plants reached around 30% of dry matter, about 02/09/2012, totaling a period of 124 days, for the treatments (TMI; TMT; TT). For the harvest, the harvester was adjusted to a particle size between 2 and 5 cm at a cutting height of 20 cm from the soil. For the evaluation of dry and green matter production a sample was collected equivalent to four linear meters. The silage of the chopped material was held in 100 mm PVC pipes (micro-silos), with a height of 50 cm and 10 cm diameter. The default compression density was 800 kg MV m³.

The micro-silos were kept sealed for 60 days, so that the fermentation was efficient. At the time of opening the silo the following parameters were determined: dry mass (DM), pH, total losses of dry matter (DML), specific mass (SM), dry mass recovery index (DMRI), losses gas during storage (LG), gas losses as a percentage of dry matter (G)

and particle size (JOBIM et al., 2007).

Silage samples were pre dried in an oven at 55° C, pounded into a Willy-type mill in a two mm sieve and stored for subsequent completion of the bromatological analyses. The DM content was determined by drying in the oven at 105 °C for at least 16 hours. OM and MM were determined by combustion at 600°C during 4 hours. Total nitrogen (N) was determined by the Kjeldahl method (AOAC, 1997) (984.13 Method). The levels of CP were calculated as $N \times 6.25$. EE content was determined by treatment of the sample with diethyl ether in reflux system, at 60° C for 4 hours (Soxhlet). The concentration of ADF was analyzed according to the 973.18 Method of AOC (AOAC, 1997). The nitrogen insoluble in acid detergents (NIDA) were analyzed according to Licitra et al. (1996).

The results were submitted to analysis of variance and, when found significant difference (5%), the averages were compared by Tukey test (p

≤ 0.05) using the SAS Statistical Software (2001).

Results and Discussions

The production of DM ha⁻¹ was lower (P0<0.01) on treatments which included corn (TMI and TMT), single Tanzania presented intermediate values and Tanzania at 32% of DM presented the best result (Table 2). Maia et al. (2000), when comparing intercropping and single millet and grass Tanzania under different sowing densities and different cuts achieved higher DM yield result in the intercropping, demonstrating the presence of millet on high production of DM.

The difference in production of DM ha⁻¹ between single and silage grass Tanzania to at 32% of DM is highly linked to canopy height of different treatments, while the single grass presented average height of 1.23 m, a Tanzania at 32% had an average height of 1.70 m (Table 3).

Table 3. Evaluation of corn silage production and agronomic data and grass-Tanzania in single or intercropping cultivation. Dois Vizinhas (PR), 2011/2012.

Variables	Treatments				Means	P>F
	Corn	Corn+tanz.	Tanzania	Tanzania 32% DM		
Production (Ton. MS/ha)	12,3±2,7C	11,4±3,1C	22,2±2,8B	43,3±2,7A	22,82	0,0001
Green leaf (%DM)	17,6±3,2C	21,8±3,7C	60,9±3,2 A	42,12±3,2B	36,1	0,0001
Dry leaf (%DM)	6,7±0,6B	10,5±0,7A	4,5±0,6B	4,74±0,6B	6,2	0,0001
Culm (%DM)	22,3±3,8C	19,6±4,4C	34,5±3,8B	51,7±3,8A	32,9	0,0001
Tassel (%DM)	1,4±0,3	2,3±0,4		3,19±0,6	2,1	0,1172
Grains (%DM)	31,6±3,8	20,2±4,7			26,4	0,1596
Straw (%DM)	10,6±0,6B	14,9±0,7A			12,7	0,0191
Cob (%DM)	10,3±0,8	10,8±1,1			10,5	0,7315
Other evaluations						
Corn Plant height (m)	1,6±0,02A	1,4±0,02B			1,5	0,0038
canopy height Tanzania (m)		1,5±0,05B	1,2±0,05C	1,7±0,05A	1,4	0,0006
Insertion of ear height (m)	0,9±0,02A	0,8±0,02B			0,9	0,0232
Plant m linear ⁻¹ (n)	8,3±0,25A	7,8±0,31A			8,1	0,0299
Plant ears (n)	1,0±0,05A	1,1±0,05A			1,0	0,0391

¹ Different letters on the same line indicate that the treatments differ among themselves at 5% of significance by Tukey test.

The lack of difference in the production of DM between single and mixed corn occurred by competition among species, this result is associated with superior height (P0<0.01) of corn in relation to

the mixed one. Despite these differences in the heights of the corn, dry matter production was not affected due to the presence of Tanzania that has added value in production. While in the Intercropping the corn had lower height, Tanzania presented a top height in the intercropping ($P < 0.01$) as related to single Tanzania, thus explaining the possible competition for light. The height of insertion of spike was also influenced by the presence of the grass, and was lower in the intercropping in function of time and competition (Table 3).

Tanzania presented the highest ($P < 0.01$) percentage of greens leaves (GL), while Tanzania at 32% of DM was superior only to the single corn and the intercropping, among which there were no differences. The percentage of dry leaves (DL) was higher in the corn intercropping + Tanzania ($P < 0.01$) being correlated to the percentage content of straw. This behavior can be explained by the high density of plants in the intercropping, thus resulting in competition between plants and greater canopy height, preventing the infiltration of light for the remainder of the plant and favoring the senescence.

Grass-Tanzania with 32% of DM showed the highest percentage of thatched roofs ($P < 0.05$), depending on the age of the plant with the late harvest, the further development of these plants had on lignification of such a structure allowing greater participation in the evaluation. This result does not favor the culture to produce silage, because this structure complicates the digestibility of food.

The grass Tanzania silage presented a higher pH value ($P < 0.01$) when compared with the other treatments (Table 4). The highest value of pH observed may be related to low soluble carbohydrates content of grass, low content of non-silage DM (22) and age of the plant, thus hampering the fermentation and quality of silage compared to other treatments. Loures et al. (2005) evaluated the chemical composition of grass -Tanzania silage under addition of Inoculants and enzymes, different sizes of particle and different levels of DM in silage wilted or not and found higher pH values in the silage without wilting. Ávila (2003) recommends the addition of Inoculants for more accelerated reduction of the pH of the grass -Tanzania silage.

Table 4. Levels of pH, particle size (PS), not silage dry matter content (DM), specified mass silage and non-silage (SM), total losses in dry matter (DML), dry mass recovery index (RDM), losses gas during storage (LG), gas losses in percentage of the DM (G) after the non-silage. Dois Vizinhos (PR), 2011/2012.

Variables	Treatments				Means	P>F
	Corn	Corn+tanz.	Tanzania	Tanzania 32%		
pH	3,5±0,10B	3,5±0,1B	4,91±0,1A	3,45±0,10B	3,86	0,0001
PS 2 mm (%)	1,6±0,3A	0,6±0,3AB	0,23±0,3B	0,83±0,28AB	0,84	0,0175
PS 4 mm (%)	9,5±1,4AB	8,5±1,5AB	6,98±1,4B	13,62±1,37A	9,72	0,0239
PS 7 mm (%)	35,3±3,1C	42,7±3,4BC	55,65±3,1A	49,59±3,07AB	45,99	0,0020
PS 12 mm (%)	20,6±2,0AB	23,7±2,3A	14,96±2,0B	15,81±2,04AB	18,51	0,0354
PS > 12 mm (%)	32,9±3,1A	24,4±3,5AB	22,17±3,1AB	18,45±3,10B	24,48	0,0307
DM non- silage (%)	30,3±0,9A	26,7±1,1A	22,00±0,9B	30,40±0,98A	27,37	0,0001
SM silage (kg)	271,6±8,6A	239,4±9,7AB	197,45±8,7C	233,88±8,68BC	235,40	0,0003
SM non-silage (kg)	290,9±9,8A	229,2±11,0B	212,82±9,84B	233,85±9,84B	242,34	0,0003
DML (%)	14,7±2,9AB	6,99±3,2B	18,61±2,91AB	19,26±2,91A	15,31	0,0520
RMS (%)	85,3±2,8AB	94,8±3,13A	80,97±2,80B	93,17±2,80A	88,23	0,0123
LG (%)	0,27±0,06B	0,42±0,06AB	0,57±0,06A	0,19±0,06B	0,36	0,0020
G (%)	14,7±3,0AB	7,0±3,4AB	18,61±3,03A	5,81±3,03B	11,77	0,0291

¹ Different letters on the same line indicate that the treatments differ among themselves at 5% of significance by Tukey test.

On the silage of single Tanzania which showed a higher pH it was also showed a lower non-silage DM content ($P<0.01$). From that, one can infer that the grass-Tanzania silage has an inferior quality when compared with the other treatments. On grass Tanzania silage with DM similar to corn (32%), about 64% of its particles were selected to the 7 mm sieve. The grass Tanzania silage had greater participation in the particle size in a 7 mm sieve ($P<0.05$), and the corn the less participation with a value of 35.3%. In a 2 mm sieve, the maize presented a percentage (1.66%) differed ($P<0.05$) of young Tanzania (0.23%). In the selection at 4 mm there was a difference only between Tanzania at 32% and single with 13.65% and 6.98% values, respectively.

The Intercropping showed the highest percentage of particles with 12 mm ($P<0.05$) while in single Tanzania a lower percentage; on a sieve over 12 mm the percentage of corn was higher (32.91%) while Tanzania 32% of DM presented the smallest percentage when compared to other treatments ($P<0.05$).

The particle size, according to Loures et al. (2005) before the decision-making on the particle size, since the higher the content of DM the smaller the particle size, the smaller shall be the loss by effluent. There is also the difference in particle size obtained in different types of silo. Neumann et al. (2005) evaluated the inaccuracy of the silage compression obtained in laboratory silos when compared to trench and surface type silos, however the ease of control, speed, greater use of physical space and possibility of comparison of different treatments lead to use of silo made of PVC pipes.

The specific mass (SM) is determined by the dimension of the plant and becomes the determining factor in the quality of the food. It is highly correlated to the particle size and content of DM, because porosity resulting from compression of the silo, associated with the amount of water may or may not extend the breathing of bacteria in sealed silo,

with higher consumption of soluble carbohydrates and even the silage itself, resulting in delay in fermentation, less lactic acid production, high pH and at the same time reduce the quality of silage. In the post-opening period, the silo can change the stability of the material (JOBIM et al., 2007). The greater compression and consequent greater DM result in greater acceptability and digestibility of feed for animals (VELHO et al., 2007).

The clamped EM was higher ($P<0.05$) for the treatments containing corn(alone and Intercropping corn), these results are associated to the DM content, particle size at 2 mm and pH lower than others, resulting in a higher quality silage. The clamped SM of the grass-Tanzania with 32% of DM was similar to the intercropping and to the single Tanzania; however the single presented lower SM Tanzania compared to other treatments.

The single corn presented a difference ($P<0.05$) as the non-silage EM, being the Tanzania a determining factor on compression and density of the silage, DM, pH-independent and TP. The mixed silage showed lower PDM, while Tanzania 32% DM, the biggest loss ($P<0.01$), corn and Tanzania presented intermediate values. Neumann et al. (2005) found no significant difference for PDM between different times of feed-out.

The Index of Dry Matter Recovery, or RDM, presents relationship with the non-silage DM content. The single grass-Tanzania presented the lowest result for bon-silage DM percentage (22%) and showed 80.97% of RDM. The largest recovery of DM was presented by the intercropping and by Tanzania with high content of DM ($P<0.05$), while corn presented intermediate values. These results reinforce the affirmative of the intercropping and older Tanzania have qualities superior to single cultures.

The loss for gases (LG) had a favorable outcome to Tanzania with highest content of DM (0.19%) ($P<0.05$) when compared to single Tanzania. The single corn also presented great values with

respect to the loss of gases (0.27%); however, in the intercropping showed no difference among the other treatments. The low percentage of DM of young Tanzania may have contributed to this result. This is a feature that can compromise the quality of silage, because fodder with low levels of dry matter does not present adequate lactic fermentation, which favors the formation of butyric acid (CASTRO et al., 2006).

Single Tanzania and the one at 32% of DM showed higher levels of MM, with 10.26 and 9.86, respectively. The intercropping showed superiority in relation to corn ($P < 0.05$), but was lower than the other treatments (Table 2). The largest concentrations of minerals for Tanzania may arise from the age of the plant, because plants in an initial development stage have more contents of minerals in their composition; another factor would be the genetic capacity of the plant to accumulate minerals.

Single corn culture presented above ($P < 0.01$) for OM feature, 95.51%. The intercropping gained 94.17%, standing out ($P < 0.01$) to single Tanzania crops. With these values, it is implied that the grass was responsible for the drop in production of organic matter when in the presence of corn, which presented the highest value. Pedó et al. (2009) found values next to corn at different heights, with an average of 95.87% organic matter with heights of 20, 45, 70 and 95 cm. Velho et al. (2007), assessing the OM of corn in different densities found that the higher the smaller the density OM, this result explains the results found in this work for the Intercropping corn x Tanzania.

To ADF, the higher result ($P < 0.01$) went to the younger grass-Tanzania with 45.67%. Tavares et al. (2009) found similar values for the witness treatment (45.95%) when compared to silage with citrus pulp 5% and pre-wilted Tanzania (42.63% and 43.72%, respectively). The reduction of the ADF by increasing the content of DM silage material is due to the best silage fermentation processes, which promotes the digestion of cellulose since the lignin

present does not change.

There has been no difference to the content of Neutral Detergent Fiber (NDF). The levels of NDF vary according to the plant species, maturity, and plant growth conditions. The analysis of the levels of NDF of fodder because of this variation and their nutritional importance (WILSON, 1994).

The levels of CP for treatment with the presence of grass showed no difference between them, while the single corn had a content lower than to others (10.4%), due to the phase of the vegetative stage of the plant at the time of harvest. The values found by Santos et al. (2008) for crude protein evaluating inoculants in Grass-Tanzania silage were 12% and 10%, before the silage and to control treatment, respectively, since the fermentation micro-organisms require nitrogen compounds for their development.

The CP values, the LIG, were superior ($P < 0.05$) for treatments with the presence of Tanzania. The single young grass presented a 9.18% value, followed by the intercropping with the value of 8.36% and later Tanzania at 32% of DM with a value of 8.15% and corn presented a value of 5.39% of LIG. Possenti et al. (2005) found lower value for corn silage LIG when compared to silage of sorghum (3.7% and 9.4%, respectively). Leonel et al. (2009) found an average of 4.3% of lignin in single corn and 4.35% in mixed corn x brachiaria. It is known that the higher the lignin content, the greater the difficulty of digestion and lower utilization of food by the animal; thus, in this case, corn presented best quality and digestibility (Table 2).

There has been no difference to the acid detergent insoluble nitrogen (ADIN). A high content of NIDA is not desirable, because the nitrogen trapped in acid detergent fiber is not tapped by ruminal micro-organisms (VAN SOEST; MASON, 1991). However, the low levels of ADIN found in this work are insufficient to compromise the availability of nutrients for animal metabolism.

Conclusions

The corn intercropping with grass-Tanzania provides a silage with a higher content of crude protein and lignin in comparison with corn exclusive silage, without harming the productivity of the crop.

The single-Tanzania silage features larger levels of ADF and crude protein, in addition to increased production of the dry matter silage corn.

Grass Tanzania must be harvested with a DM of 30% since it presented best values of pH, higher rate of recovery of DM, less loss of gases, as well as increased dry matter production, than the Tanzania harvested with the same age of the corn.

References

ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS - AOAC International. Official methods of analysis. 16. ed. 3. rev. Gaithersburg: Published by AOAC International, 1997. v. 2, cap. 32, p. 1-43.

ÁVILA, C. L. da S.; PINTO, J. C.; EVANGELISTA, A. R.; MORAIS, A. R. de; FIGUEIREDO, H. C. P.; TAVARES, V. B. Perfil de fermentação das silagens de capim-Tanzânia com aditivos -teores de nitrogênio amoniacal e pH. *Ciências Agrotecnicas*, Lavras, v. 27, n. 5, p. 1144-1151, 2003.

BHERING, S. B.; SANTOS, H. G. *Mapa de solos do Estado do Paraná*: legenda atualizada. Rio de Janeiro: EMBRAPA/IAPAR, 2008. 74 p.

CASTRO, F. G. F.; NUSSIO, L. G.; HADDAD, C. M.; CAMPOS, F. P.; COELHO, R. M.; MARI, L. J.; TOLEDO, P. A. Características de fermentação e composição químico-bromatológica de silagens de capim-tifton 85 confeccionadas com cinco teores de matéria seca. *Revista Brasileira de Zootecnia*, Viçosa, MG, v. 35, n. 1, p. 7-20, 2006.

CORRÊA, C. E. S.; SHAVER, R. D.; PEREIRA, M. N.; LAUER, J. G.; KOHN, K. Relationship between corn vitreousness and ruminal in situ starch degradability. *Journal of Dairy Science*, Cambridge, v. 85, n. 11, p. 3008-3012, 2002.

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA - EMBRAPA. Custos de forrageiras. Juiz de Fora: Embrapa Gado de Leite, 2005. Disponível em: <<http://www.cnpqgl.embrapa.br/nova/informacoes/custos/custos2.php>>. Acesso em: 2 abr. 2011.

INSTITUTO NACIONAL DE METEOROLOGIA - INMET. Dados climáticos da estação automática de Dois Vizinhos. [S.l.; s.n], 2011. Disponível em: <<http://www.inmet.gov.br>>. Acesso em: 10 jul. 2011.

JOBIM, C. C.; NUSSIO, L. G.; REIS, R. A.; SCHMIDT, P. Avanços metodológicos na avaliação da qualidade da forragem conservada. *Revista Brasileira de Zootecnia*, Viçosa, MG, v. 36, p. 101-119, 2007. Suplemento Especial.

LEONEL, F. P.; PEREIRA, J. C.; COSTA, M. G.; MARCO JUNIOR, P. de; SILVA, C. J.; LARA, L. A. Consórcio capim-braquiária e milho: comportamento produtivo das culturas e características nutricionais e qualitativas das silagens. *Revista Brasileira de Zootecnia*, Viçosa, MG, v. 38, n. 1, p. 166-176, 2009.

LICITRA, G.; HERNANDEZ, T. M.; VAN SOEST, P. J. Standardization of procedures for nitrogen fractionation of ruminant feeds. *Animal Feed Science and Technology*, Madrid, v. 57, n. 4, p. 347-358, 1996.

LOURES, D. R. S.; NUSSIO, L. G.; PAZIANI, S. de F.; PEDROSO, A. de F.; MARI, L. J.; RIBEIRO, J. L.; ZOPOLLATTO, M.; SCHMIDT, P.; JUNQUEIRA, M. C.; PACKER, I. U.; CAMPOS, F. P. de. Composição bromatológica e produção de efluente de silagens de capim-tanzânia sob efeitos do emurchecimento, do tamanho de partícula e do uso de aditivos biológicos. *Revista Brasileira de Zootecnia*, Viçosa, MG, v. 34, n. 3, p. 726-735, 2005.

MAIA, M. C.; PINTO, J. C.; ANDRADE, I. F. de. Estabelecimento de pastagem de Capim-tanzânia usando milho como cultura acompanhante. *Revista Brasileira de Zootecnia*, Viçosa, MG, v. 29, n. 5, p. 1312-1319, 2000.

NEUMANN, M.; RESTLE, J.; BRONDANI, I. L.; NÖRNBERG, J. L.; MELLO, R. de O.; SOUZA, A. N. M. de; PELLEGRINI, L. G. de. Efeito do tamanho da partícula e do tipo de silo sobre o valor nutritivo da silagem de sorgo (*sorghum bicolor*, L. Moench). *Revista Brasileira de Milho e Sorgo*, Sete Lagoas, v. 4, n. 2, p. 224-242, 2005.

PEDÓ, L. F. B.; NÖRNBERG, J. L.; VELHO, J. P.; HENTZ, F.; HENN, J. D.; BARCELLOS, J. O. J.; VELHO, I. M. P. H.; MARX, F. R. Fracionamento dos carboidratos de silagens de milho safrinha colhidas em diferentes alturas de corte. *Ciência Rural*, Santa Maria, v. 39, n. 1, p. 181-194, 2009.

POSSENTI, R. A.; EVALDO JUNIOR, F.; BUENO, M. S.; BIANCHINI, D.; LEINZ, F. F.; RODRIGUES, C. F. Parâmetros bromatológicos e fermentativos das silagens de milho e girassol. *Ciência Rural*, Santa Maria, v. 35, n. 5, p. 1185-1189, 2005.

- SANTOS, E. M.; ZANINE, A. M.; FERREIRA, D. J.; OLIVEIRA, J. S.; PENTEADO, D. C. S.; PEREIRA, O. Inoculante ativado melhora a silagem de capim-tanzânia (*Panicum maximum*). *Archivos Zootecnia*, Cordoba, v. 57, n. 217, p. 35-42, 2008.
- STATISTICAL ANALYSIS SYSTEM - SAS. System for Microsoft Windows: release 8.2. Cary: Statistical Analysis Systems, 2001. CD-ROM.
- TAVARES, V. B.; PINTO, J. C.; EVANGELISTA, A. R.; FIGUEIREDO, H. C. P.; ÁVILA, C. L. da S.; LIMA, R. F. de. Efeitos da compactação, da inclusão de aditivo absorvente e do emurchecimento na composição bromatológica de silagens de capim-Tanzânia. *Revista Brasileira de Zootecnia*, Viçosa, MG, v. 38, n. 1, p. 40-49, 2009.
- VAN SOEST, P.J.; MASON, V.C. The influence of Maillard reaction upon the nutritive value of fibrous feeds. *Animal Feed Science and Technology*, Madrid, v. 32, n. 1-3, 1991, p.45-53.
- VELHO, J. P.; MÜHLBACH, P. R. F.; NÖRNBERG, J. L.; VELHO, I. M. P. H.; GENRO, T. C. M.; KESSLER, J. D. Composição bromatológica de silagens de milho produzidas com diferentes densidades de compactação. *Revista Brasileira de Zootecnia*, Viçosa, MG, v. 36, n. 5, p. 1532-1538, 2007.
- WILSON, J. R. Cell wall characteristics in relation to forage digestion by ruminants: review. *Journal Agriculture Science*, Jordan, v. 122, n. 2, p. 173-182, 1994.
- ZEOULA, L. M.; BELEZE, J. R. F.; CECATO, V.; JOBIM, C. C.; GERON, L. J. V.; PRADO, P. P.; FALCAO, A. J. S. Avaliação de cinco híbridos de milho (*Zea mays*, L.) em diferentes estágios de maturação. 4. Digestibilidade de matéria seca, matéria orgânica e fibra em detergente neutro da porção vegetativa e planta inteira. *Revista Brasileira de Zootecnia*, Viçosa, MG, v. 32, n. 3, p. 556-566, 2003.